Human Exploration Telerobotics: Developing Robots To Complement Human Explorers

Key Facts

- Future human missions to the moon, Mars, and other destinations offer many new opportunities for exploration. However, crew time will always be limited and some work will not be feasible for astronauts to do manually.
- Robots can do a variety of work to increase the productivity of human explorers. Robots can perform tasks that are tedious, highly repetitive or long-duration, such as conducting site surveys or routine maintenance. Robots can perform work that is beyond human capability, such as operating in dangerous environments and performing tasks that require great force.
- Robots can perform work ahead of humans, such as scouting, that help prepare for future manned activity and missions. Robots can also perform “follow-up” work after humans leave, completing tasks started by humans, or conducting supplementary tasks designated by humans.
- A central challenge is to understand how human and robot activities can be coordinated to maximize crew safety, mission success, and scientific return.

NASA's Human Exploration Telerobotics project develops robots that astronauts aboard the International Space Station -- as well as ground controllers on Earth -- can operate remotely. These telerobots will improve the efficiency, effectiveness, and productivity of future human deep-space missions.

OBJECTIVES

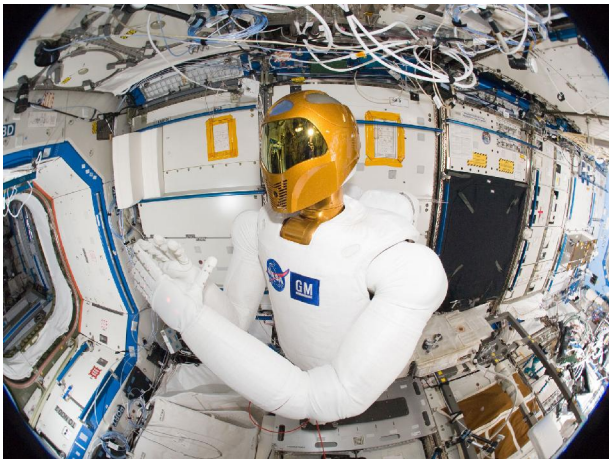
During future missions beyond low-Earth orbit, some work will not be feasible for humans to do manually. Robots will complement human explorers, allowing astronauts to perform work via remote control from a space station, spacecraft, or other habitat. The primary goal of the Telerobotics project is to understand how human and robot activities can be coordinated to improve crew safety, science and mission success while also reducing cost, risk and consumables like fuel and oxygen during future exploration missions.

OVERVIEW

The Telerobotics project develops, tests and demonstrates how astronauts in space, and flight controllers on Earth, can operate robots remotely during human exploration missions. To date, much of this work was performed aboard the International Space Station. This allows for high-fidelity simulations of future human missions, including a micro-gravity environment, long durations in space, flight vehicle constraints and operational complexity (such as coordination with mission control, scheduling crew activities and satellite communications).

The Telerobotics project currently encompasses three advanced robots: Robonaut 2; Smart Synchronized Position Hold, Engage and Reorient Experimental Satellites (Smart SPHERES); and Surface Telerobotics.

Robonaut 2 (R2) is the first humanoid robot in space. R2 is the latest result of a long-term NASA effort to develop robots that can operate safely near humans and can use the same tools and hardware (like connectors and switches) as astronauts. R2 is being used aboard the space station to demonstrate highly repetitive tasks that require dexterous manipulation, routine maintenance and repair work.



Smart SPHERES are free-flying robots equipped with cameras, accelerometers, wireless networking and smartphone-based embedded computing. The Smart SPHERES are designed to perform work on the space station that requires mobile sensing, such as environmental surveys to detect levels of radiation, lighting and air quality, as well as monitoring inventory and experiments.

A prototype smartphone-enhanced SPHERES. Image credit: NASA/Ames/DW Wheeler.

Surface Telerobotics is a system that allows astronauts in space to operate remotely a robot to perform work on a planetary surface. The current system uses the K10 planetary rover, housed and ready to deploy to analog sites from NASA's Ames Research Center, Moffett Field, Calif. The K10 allows astronauts to survey remotely a location, deploy equipment and instruments and perform inspection or photographic documentation.

TESTS

The Telerobotics project will be performing four tests involving the International Space Station in 2013 and three in 2014.

March 2013: Crew conducts simulated EVA repairs with Robonaut 2 teleoperation equipment.
June-August 2013: Crew controls K10 rover to conduct a simulated telescope deployment.
July 2013: Crew conducts simulated EVA visual inspection using Smart SPHERES.
September 2013: Ground-controlled Robonaut 2 manipulates IVA and EVA interfaces.
May 2014: Crew teleoperates Robonaut 2 to manipulate stowage interfaces.
June 2014: Ground controls Smart SPHERES to conduct an astronaut interview.
July 2014: Robonaut 2 IVA mobility test.

The tests that the Telerobotics project performs on the space station will help reduce risk by maturing, assessing and proving the technologies future human and robotic missions will use. In addition, the results of these tests will help develop new approaches to telerobotics and enable innovative ways for humans and robots to explore space.

The Telerobotics project is managed by the Intelligent Robotics Group at Ames. The project involves research and development at Ames; NASA's Johnson Space Center in Houston; and the agency's Jet Propulsion Laboratory in Pasadena, Calif. Support for the project is provided by the NASA Technology Demonstration Missions program.

For more information, visit:
http://www.nasa.gov/telerobotics